MISR Level 2 Top-of-Atmosphere/Cloud Products Quality Statement
November 12, 2002

Quality Designator: Provisional

MISR maturity level definitions

This statement applies to MISR Level 2 TC Stereo, Albedo and Classifiers for November 12, 2002, and beyond until such a time as further improvements to MISR software are made. Quality statements covering earlier time periods may be accessed through links at the bottom of this page.

An extensive review of product quality has not yet been performed. Please read the summary words of caution if you have not done so already.

Many of the algorithms used in the product retrievals have been developed specifically for the MISR instrument, and as such, are relatively untested. We expect to improve on these algorithms as we gain experience with the data. Trade-offs with the stereo-matching algorithms have been made at times to sacrifice accuracy or coverage for speed and vice-versa.

In spite of all the warnings, the MISR Level 2 TC Stereo, Albedo and Classifiers software which generated these products is believed to be functioning quite well except where noted below. This statement highlights major known problems with the products, as well as functionalities which are currently not implemented.

L2TC Stereo (a.k.a. TC_STEREO) (from MISR PGE8a)

The Cloud-Motion Vectors (winds), Stereo Heights, SDCM, and RLRA are now of Provisional quality. A study of the MISR-retrieved winds against GOES data is published in the vol. 28, 2001 issue of GRL. Height Comparisons made with MODIS, radar, and computationally intensive stereo matching algorithms are now documented in the July 2002 issue of IEEE-TGARS and in the August 2002 issue of GRL. Overall, there is good agreement between MISR cloud heights and those obtained from other sources.

Several factors affect the quality of the stereo heights including the nature of the scene being matched, the co-registration of the different cameras in Level 1, and the accuracy of the wind retrievals.

EXPECTED ACCURACY
Under good conditions with perfect registration (see Registration paragraph below), the winds are expected to be accurate to within 3 m/s with a corresponding height error of 400m. The stereo heights themselves are quantized in units of 550 m. The stereo-matchers lack subpixel accuracy and a single pixel of disparity difference translates into 550m of height. In general, the stereo-matchers are accurate to within one pixel. Results with cloud-free scenes indicate a height error distribution with a standard deviation up to 1.1 km and up to 1.5 km for comparisons against radar cloud-top heights. The mean height error found in studies of clear scenes was less than the 550 m height resolution.

WIND RETRIEVAL QUALITY AND HEIGHT BLOCKINESS
The accuracy of the cloud motion retrieval is a key component in the cloud-top height calculation. The winds are very sensitive to any misregistration of the oblique angles, and discontinuity in the wind vectors shows up as clearly visible "blockiness" in the stereo heights. Drop-outs in the wind vectors result in a default wind field of zero being applied and this will also show itself as blockiness in the heights. In addition, failure of the stereo-matchers will also cause poor quality winds on occasion.

Quality flags for each individual wind vector are now included in the TC product. These flags are computed by looking at the signal strength returned from the stereo-matchers and are purposely set to be on the conservative side - good quality winds may be deemed bad on occasion but very few poor quality winds should be mislabelled as good. An individual wind-vector should only be considered of Provisional quality if the Orbit_QA flag indicates "good", the mean misregistration retrievals for the Df camera is zero, and the individual wind-qa flag indicates "good" or "very good". The Da camera is currently not used, see the Registration section for more information.

CLOUD-TOP HEIGHT CATEGORIZATION
With the addition of the WindQA flags to the product, the StereoHeights and all related fields are now produced in three different types - BestWinds, WithoutWinds and RawWinds.

The BestWinds parameters are only computed for those domains in which a wind retrieval (a) succeeded and (b) was of Good or VeryGood quality. They are set to NoRetrieval otherwise. These heights comprise our best guess of what the true stereo height is for each pixel. There is still some blockiness present but it is greatly diminished from previous versions of the cloud-top heights. The WithoutWinds data are calculated assuming a constant value of zero wind everywhere. Over clear or motionless areas, the WithoutWinds will equal the actual stereo height, everywhere else they instead yield a "relative height". The blockiness due to wind discontinuity is removed and the relative variation in

the heights over small areas is correct.

The RawWinds product uses all available wind retrievals regardless of their quality with a default to zero wind when no cloud motion vector is available. This is the same algorithm used in previous versions of the stereo product. Therefore the heights will be blocky due to discontinuities and drop-outs in the wind vectors. This is intended as a diagnostic field to allow assessment of the cloud-top height improvement due to the inclusion of the WindQA flags.

REGISTRATION OF LEVEL 1 DATA AND ORBIT QUALITY FLAG
Level 1 now includes an Orbit Quality (Orbit_QA) flag that assesses the registration quality of the orbit based on the "dprep" (attitude and ephemeris) data. All of the TOA/Cloud products now read in this quality flag. If the flag indicates that the registration quality of the orbit might be poor, all the BestWind height products in the TC_STEREO file are set to NoRetrieval since it is impossible to retrieve good quality winds if the registration is inaccurate. This decision is made on an orbital basis and is flagged in both the Orbit_QA and CloudMotionSource flags.

There is also an issue with the georectification accuracy of the Da camera as compared with the other eight cameras. Da camera data acquired outside of the time period August 2000 - July 2001 occasionally exhibits a mean geolocation error of up to 800m. Please see the Georectification Page for more details. In compensation, the wind retrieval process currently does not use the Da camera. To counteract the decreased signal entering the wind retrieval process, the wind retrieval threshold has been halved, possibly resulting in slightly noisier winds. However, the bias due to the Da camera misregistration has been removed.

The registration accuracy of the Df and Da cameras in both the along and across-track directions are also reported in the product at 70.4km resolution. These retrievals generally succeed over clear-sky land, and calculate the misregistration of the D cameras in units of 275m pixels.

MULTI-LAYER SCENES
Multi-layer scenes and those without a great deal of contrast cause problems for the stereo-matching algorithms. The variation in cloud opacity with view angle, in particular, makes the wind retrieval (and therefore accurate height calculation) difficult. In such cases, MISR will match the layer of greatest contrast, rather than the highest heights. High, thin clouds over a lower-level cloud deck are ignored.

OTHER PROBLEMS
The stereo-matchers lack a robust blunder detection algorithm and will therefore retrieve spurious results on occasion. This results in areas of "noise" in the stereo height field. The scene is pre-screened for sufficient contrast and a failure in this test results in a NoRetrieval in the stereo heights, but sometimes low contrast scenes are matched and will result in difficulties applying the stereo matchers correctly.

Sometimes horizontal stripes of NoRetrieval values will appear in the product. See the Exceptions/Anomalies paragraph in the Level 1 Quality Statement for more details.

DATA SOURCE FLAGS
The Orbit_QA, CloudMotionSource, WindQuality and StereoHeightSource flags all contain key information about the source of the TC_STEREO data. Their values are listed below. The Orbit_QA flag is contained in the global file attributes, the others are available as gridded data fields at the appropriate resolution.
Orbit_QA: (-9999.0 = NoRetrieval, -1.0 = Poor Registration, 0.0 = Nominal Registration).
CloudMotionSource: (0=Stereo Not Attempted, 1=Wind Retrieval Failed due to poor Orbit_QA flag, 2=Stereo Attempted and Failed, 3 = Stereo Succeeded for Low Cloud only, 4 = Stereo Succeeded for High Cloud only, 5 = Stereo Succeeded for Low and High Clouds)
WindQuality: (0 = NoRetrieval, 1 = Bad, 2 = Uncertain, 3 = Good, 4 = VeryGood).
StereoHeightSource: (0= NoRetrieval, 1 = Stereoscopically Determined height, 2 = Surface Override, 3 = Default Cloud, 4 = MODIS height).

FILE FORMAT UPDATES
The TC_STEREO product has undergone extensive revision: most of the 1.1km and 2.2km resolution field names have been changed, and they have also been re-ordered to put the most important fields at the top of each grid. Please see the Data Products Specifications document for full details.

EXTERNAL DATA SOURCES
No external data sources such as the MODIS cloud-heights and the DAO/NSIDC snow-ice masks are used in the L2TC Processing. The snow-ice data are instead provided by monthly, static climatological inputs from the TASC Dataset.

ALGORITHM UPDATES
There have been several updates to the algorithms described in the ATBD. First, the 2-D histogram used for the wind retrieval now employs a bin- expansion algorithm and we no longer average together separate wind bins, instead we choose the bin with the smallest height range. If there is no stereoscopically retrieved height available, the StereoHeight and SDCM are set to NoRetrieval except in the case of clear-sky over ocean (as determined by the value of the Radiometric Camera-by-Camera Cloud Mask - RCCM) where the surface height is substituted for the missing stereo height. The Reflecting Level Reference Altitude (RLRA) is set to NoRetrieval where there is no stereo height, rather than being filled in with default values.

L2TC Classifiers (a.k.a. TC_CLASSIFIERS) (from MISR PGE8b)

The altitude-binned scene classifiers as computed from the SDCM and PrelimSDCM are now of Provisional quality following the declaration of their parent products as Provisional. The RCCM based cloud-fractions are of Provisional quality over water, and Beta quality over land. The BestWinds version of the TC_STEREO data is used in all these calculations.

ASCM NOT AVAILABLE

The Angular Signature Cloud Mask (ASCM) designed to be used for the detection of high clouds is not yet implemented. Both the cloud mask and the associated classifiers are set to NoRetrieval.

CLOUD AND TOPOGRAPHIC SHADOW MASKS NOT AVAILABLE
The cloud and topographic shadow masks are currently not part of the Classifiers product.

CLOUD CLASSIFIERS FIELDS
Since the algorithm for determining the cloud classifiers is so simple, the quality of these products is directly derived from the incoming data. Therefore, one is urged to pay close attention to the quality statements for the SDCM, RCCM and ASCM.

L2TC Albedo (a.k.a. TC_ALBEDO) (from MISR PGE8c)

The Top-of-Atmosphere BRF's (and all accompanying parameters such as the top and side BRF's and the number of unobscured pixels), the first texture index and the Local Albedos are Provisional. The Restrictive and Expansive albedos are also Provisional. The local albedos are internally consistent regardless of the modelling method used and compare well with the BRF images, and the restrictive and expansive albedos also pass visual inspection.

The accuracy of the albedos is limited by two factors - radiometric calibration and bidirectional corrections. All information in the Calibration Quality statement applies equally well to the albedos. The main bidirectional limitation applies to clear scenes at high latitudes. At present these are not corrected for azimuthal effects and consequently grossly exaggerate the true albedo. This affects all albedo products over clear snow or ice at high latitudes.

There is no detectable bias difference between the expansive and restrictive albedos. Regionally, their rms difference is approximately 0.04 to 0.10 depending on solar zenith angle. Based on limited studies to date, the rms uncertainty due to bidirectional modeling ranges from less than 0.01 at low latitudes to 0.03 at high latitudes (cloudy scenes only).

CALIBRATION
The reader is urged to pay close attention to the quality of the radiometric calibration as there have been some recent changes made. See the Radiometric Calibration section of the Level 1 Quality Statements.

CLEAR-SKY DETERMINISTIC MODELLING MISSING
The clear-sky deterministic modelling algorithm as described in the ATBD is not yet implemented. When the scene is determined to be clear (by looking at the SDCM), all the local albedo components are calculated using solid-angle weighting.

GREY-LEVEL DIFFERENCE VECTORS NOT AVAILABLE
The grey-level difference vectors (the second and third texture indices) as described in the ATBD have not yet been implemented. They are therefore set to NoRetrieval throughout the swath.

FACTORS AFFECTING ALBEDO INTERPRETATION
The local albedo is defined as the unobscured reflection from the 2.2km RLRA and will therefore often appear to be lower than would be expected. If the local albedos are not summarized statistically but instead are looked at on an individual basis, only the ones that have no obscuration should be used. (This information is available at 2.2km resolution in the NumUnobscuredTop field. Any number >= 64 indicates that there was no obscuration).

Small fluctuations in the value of the RLRA will directly affect the obscuration and the local albedo. For continuous scenes, a 500m RLRA difference (due to pixel quantization and other factors) typically results in up to a 10% difference in the local albedo due to obscuration effects. This effect is generally not as noticeable in scenes with naturally discontinuous height fields.

FILE FORMAT CHANGES
The TC_ALBEDO product has also undergone extensive revision: most of the field names have been changed, and they have also been re-ordered to put the most important fields at the top of each grid. Please see the Data Products Specifications document for full details.

LOCAL ALBEDO MODELLING ALGORITHMS
The Local Albedo calculation is first attempted by Deterministic Modeling (if the scene is homogenous), then Stochastic Modeling and finally solid-angle weighting. No modeling is attempted for clear-sky pixels or where the solar zenith angle is < 25.8 degrees.

ALGORITHM UPDATES FROM ATBD REV. D
The algorithm for reprojecting the BRF's up to the RLRA was found to be flawed and has been completely replaced with a new backwards-projection algorithm that reprojects the BRF's up to the RLRA.

Also see the:

- Statement dated April 15, 2002 for MISR Level 2 Top-of-Atmosphere/Cloud Products from April 15 to November 11, 2002.
- Statement dated December 03, 2001 for MISR Level 2 Top-of-Atmosphere/Cloud Products from December 03 to April 14, 2002.
- Statement dated September 27, 2001 for MISR Level 2 Top-of-Atmosphere/Cloud Products from September 27 to December 03, 2001.
- Statement dated March 30, 2001 for MISR Level 2 Top-of-Atmosphere/Cloud Products from March 30 to September 27, 2001.
- Statement dated February 16, 2001 for MISR Level 2 Top-of-Atmosphere/Cloud Products from February 16 to March 30, 2001.